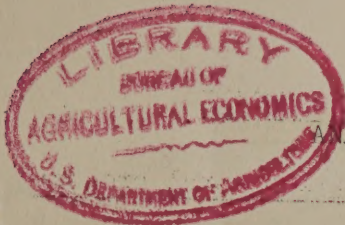


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ANALYSIS OF THE INCREASE IN EFFICIENCY OF AGRICULTURAL
PRODUCTION, 1919-20 TO 1932-33.

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INTRODUCTION

Through the past decade, a great deal has been written about the increase in efficiency of agricultural production. In general, an increased net production of food and agricultural raw materials relative to either the crop acreage harvested, or to farm population, is considered as an increase in the efficiency of production. In this section an attempt will be made to measure and explain the increase in the efficiency of production which has taken place since 1919-20.^{1/}

The increase in the efficiency of agricultural production may be measured either by comparing the changes in the number of acres of land required to supply food and clothing for domestic consumption with the changes in population, or by comparing the changes in the index of net agricultural production with the changes in the crop acreage harvested and in farm population from 1919-20 to the present.

1/ For an excellent analysis of the increase in efficiency of agricultural production from 1917-21 to 1922-26, see: O. E. Baker, Changes in the Production and Consumption of Our Farm Products and the Trend in Population, The Annals of the American Academy of Political and Social Science, March 1929. Dr. Baker decided that net production had increased about 15 per cent, while crop acreage had remained almost constant. About 30 per cent of this increase was attributed to the replacement of horses and mules by the automobile and tractor and the consequent release of feed for animal production; about 30 per cent to the increased production of milk and meat per unit of feed; about 10 per cent to the shift from the production of sheep and beef to the increased production of pork and milk; about 20 per cent to the shift from corn to cotton in the Cotton Belt, from wheat to corn in the Corn Belt, and from sod to wheat in the Great Plains Region, and about 10 per cent to the increased yield per acre of wheat and cotton.

EFFICIENCY AS MEASURED BY ACRES REQUIRED FOR PRODUCTION

According to the acreage method, the volume of not agricultural production increased approximately 8 per cent relative to the acreage required at average yields for gross agricultural production between 1920-1922 and 1931-1933.^{2/} That is, a decrease equivalent to about 30 million acres, or 8 per

Table 1.- Harvested Acres at Average Yields Equivalent to Consumption of Domestically Produced Products, Total and Per Capita, 1920 to 1933.

Year	Crop	U. S.	Acres Per Capita		
	Acreage 1/	Population	Food	Non-Food	Total
	Required	July 1			
	Acres	Number	Acres Per Capita		
1920	277,587,000	106,543,000	2.43	.18	2.61
1921	275,573,000	108,208,000	2.39	.16	2.55
1922	289,828,000	109,873,000	2.46	.18	2.64
1923	289,214,000	111,537,000	2.42	.17	2.59
1924	298,406,000	113,202,000	2.46	.18	2.64
1925	285,562,000	114,867,000	2.28	.21	2.49
1926	292,326,000	116,532,000	2.30	.21	2.51
1927	286,026,000	118,197,000	2.21	.21	2.42
1928	310,602,000	119,862,000	2.37	.22	2.59
1929	305,014,000	121,526,000	2.31	.20	2.51
1930	293,291,000	123,191,000	2.20	.18	2.38
1931	283,754,000	124,070,000	2.12	.17	2.29
1932	286,920,000	124,822,000	2.16	.14	2.30
1933	311,627,000	125,693,000	2.31	.17	2.48

1/ Acres required at average yields corrected for acres required for exports and such changes in stocks as are recorded.

cent of the average crop acreage harvested, is indicated when the acreage at average yields required to supply the consumption of domestically produced agricultural products is compared with the increase in population from 1920-1922 to 1931-1933. The acreages at average yields required to supply the

2/ The two 3-year periods, 1920 to 1922 and 1931 to 1933, were chosen because they are similar periods with regard to industrial production and the deflation of the general price level, because they represent the earliest and latest periods for which certain data are available, and because a period of at least 3 years was required in order to obtain a stable average of yields, production, and consumption.

consumption of such agricultural products as are domestically produced, and the population on July 1, are given in Table 1. The acreage required for domestic consumption is so calculated as to reflect all of the increases in the efficiency of agricultural production which have occurred in the United States since 1919-20.

It required 2.60 acres per capita to supply the average consumption of agricultural products domestically produced in the 3-year period 1920-1922 as compared with 2.36 acres per capita in the 3-year period 1931-1933. Or, if the population in the second period had required the same acreage per capita as in the earlier period, an increase of 43 million acres at average yields would have been required as compared with an actual increase of only 13 million acres at average yields of harvested crop land chargeable to domestic consumption.

Since the per capita consumption of agricultural products in 1920-22 was almost the same as in 1931-33, the difference of 30 million acres represents an 8 per cent gain or increase in efficiency of production on a base of 360 million acres of harvested crop land. The per capita consumption of wheat flour was at about the same level in 1931-1933 as in 1920-1922. The consumption of potatoes and corn meal decreased but such data as are available indicate that the decreases were offset by increases in the consumption of such vegetables as lettuce, string beans, celery, and spinach, and of such corn products as corn flakes and corn starch. A decline in the consumption of apples was offset by an increase in the consumption of citrus fruit. The consumption of butter, cheese, and so far as is known, of fluid milk, was either maintained or increased. Meat consumption remained about constant. A decrease in the consumption of cotton was offset in part by an increase in rayon consumption.

Approximately 90 per cent of the increase in agricultural efficiency from 1920-1922 to 1931-1933, as measured by the acreage required for net production, was due to the decrease in the horse and mule population and the consequent release of crop acreage for commercial production. It is estimated that the increasing mechanization of agriculture resulted in the release of about 27.5 million acres of crop land from producing feed for workstock through the period in question. The estimate of the acreage released is based upon an estimated decrease of almost 7.4 million head of horses and mules on farms, a decrease of 1.5 million head in cities and towns, and an average allowance of 3.1 acres of harvested crop land per head. It should be remembered that the decrease in horses and mules also released a large acreage of pasture land as well as the 27.5 million acres of crop land.

The additional 2.5 million acres of the gain in efficiency or agricultural production, as measured by the acreage required for net production, was apparently due to an increase in the efficiency of production relative to the quantity of hay fed to livestock. A reasonable explanation of this increase is offered by the released acreage of pasture land. Changes in the per capita consumption and acreage requirements for the several specific products were such as to almost exactly offset each other.

So far, the use of acreages at average yields has eliminated changes due to the yield factor. Although average yields decreased enough between 1919-1921 and 1930-1932 to offset approximately 8 million of the 30 million acres gained, it is doubtful if the apparent decrease can be considered as permanent. With an allowance for the yield factor included, the increases in the acreage required for domestic consumption were:

Average acres for increased population - - - - 43.0 million

Average acres to offset decreased yields - - - 8.0 million

The increased acreages required for domestic consumption and to offset the decreased yields were obtained from:

Actual increase in acres for consumption	- - - -	21.0 million
Average acres released by workstock	- - - - -	27.5 million
Average acres released by economical feeding and changes in demand	- - - - -	2.5 million

The actual increase of 21 million acres in the acreage for domestic production, together with a net increase in the stocks of agricultural commodities equivalent to the average product of 8 million acres at average yields from the crops of 1930 to 1932 as compared with 1919 to 1921, were offset by a decrease in the exports of agricultural products equivalent to the production of about 29 million acres at average yields between 1920-1922 and 1931-1933.

EFFICIENCY AS MEASURED BY THE INDEX OF NET PRODUCTION

According to the index method, the volume of net agricultural production increased approximately 16 per cent relative to both harvested crop acreage and farm population between 1920-1922 and 1931-1933.^{3/} This is shown in Table 2, where net agricultural production is compared with harvested crop acreage and farm population from 1919 through 1933. The actual increase in efficiency or in relative production apparently came in the first half of the

^{3/} The net index of agricultural production is based on estimates of production for sale and for consumption in the farm home. Production fed to livestock or used for seed is not included. The index is calculated by weighting crop year production of crops and calendar year production of livestock by prices received by producers for the period 1919-1927. For a brief description of the index of net total production and the indexes of grain, fruit and vegetable, truck crop, meat animal, dairy, poultry, and cotton and cottonseed production which are combined in the total index, see: Table 457, 1934 Yearbook, U.S. Department of Agriculture.

period. From 1920-1922 to 1931-1933, net agricultural production per harvested crop acre increased from 90 to 104 per cent of the average for the 1919-1933 period, but the average production per acre was also 104 per cent of the average for the base period in 1925-1927. An almost identical result is obtained if net production is compared with farm population.

The analysis in which the acreage required for production was used indicated an increase in the efficiency of agricultural production of 8 per cent as

Table 2.- Harvested Crop Acreage and Farm Population Relative to Net Agricultural Production, 1919-1933.^{1/}

Year	Harvested Crop Acreage	Farm Population July 1	Net Agricultural Production		
			Total	Relative to Harvested Acreage	Relative to Farm Population
			1919-1933 = 100		
1919	102	102	88	86	86
1920	101	102	94	93	92
1921	101	102	85	84	83
1922	99	102	93	94	91
1923	99	102	98	99	96
1924	99	100	103	104	103
1925	101	100	103	102	103
1926	100	100	108	108	108
1927	100	98	103	103	105
1928	101	98	108	107	110
1929	102	97	106	104	109
1930	102	97	104	102	107
1931	100	98	109	109	111
1932	101	100	101	100	101
1933	92	102	97	105	95

^{1/} Harvested acreage as compiled by R. B. Ezekiel. Farm population on July 1 obtained by interpolation. Net production as reported in Table 457, 1934 Yearbook of Agriculture.

compared with the increase of 16 per cent indicated by the use of the index of net agricultural production. The analysis based on the index of net agricultural production measured the increase in efficiency due to the shift to the crops and classes of livestock which returned the most value per acre of land, or per animal, through the period under consideration, as well as to the increase in production relative to the acreage required.

The additional increase in the apparent efficiency of production was due to a general shift in crop and livestock production.^{4/} The acreages of hay and wheat, which return a low value per acre, were both decreased. On the other hand, the acreages and production of such crops as cotton, tobacco, sugar beets, and truck, which return a high value per acre, were increased. For example, the production of cotton, which was worth twice as much per acre as hay or wheat in the base period selected for the index of net production, was increased approximately 40 per cent from 1919-1921 into 1930-1932. In addition to the crop acreage shift, the number of dairy cattle increased about 16.5 per cent and the number of beef cattle decreased about 23 per cent. The net result was an almost stable production of beef and a 25 per cent increase in milk production, so that the net product per animal was greatly increased.

The shift to the crops and livestock which returned the most value per acre, or per animal, was especially marked from 1919-20 to about 1927-28. This movement toward specialization of production, together with the liquidation of hogs in 1923 and 1924 and of beef cattle in 1924 to 1927, caused the index of net agricultural production to increase 16 per cent relative to either acreage or population between 1920-1922 and 1925-1927. A reversal of the trend toward specialization and a cessation of the excessive marketing of livestock stabilized the index of net agricultural production so that the relative gain of 16 per cent was only maintained into 1931-1933 despite the continued decrease in the number of horses and mules and the consequent release of crop land.

^{4/} An additional consideration, and one still to be investigated, is the location of the released acreages of crop and pasture land. It is possible that the greater portion of the decrease in the horse and mule population came in the more fertile portion of the United States and that better than average land was released.

So far, the discussion has been concerned with the increase in production relative to land or to the farm population. Were it possible, it would be desirable to measure the increase in production relative to the equipment used or the capital invested in the farm plant. It is known, of course, that the land and buildings used in agricultural production were not much changed between 1920 and 1930. So far as equipment is concerned, however, it is certain that the observed mechanization of agriculture has resulted in an increased use of equipment even though it has been obscured by the general improvement in the performance of most of the machinery and equipment used in agriculture and the downward trend in the price level from 1919-20 to 1932-33. And although the general movement toward mechanization has resulted in an increased production relative to farm population, it should be remembered that an increased demand has been created for the services and products of the mines, the machine shops, the sales force, and the transportation system.

WILL THE PRESENT EFFICIENCY OF PRODUCTION BE MAINTAINED?

An estimate of the future trend in the efficiency of production must consider the probable trend toward mechanization, the probable trend in the yields of such crops as corn, wheat, and cotton, the probable trend in the efficiency of livestock production, and the probable trend toward specialization or concentration. On the whole, it is probable that efficiency of agricultural production relative to either acreage of harvested crop land or population can be maintained or increased through the next decade, provided agricultural prices are maintained at a reasonable level.

It is probable, of course, that the gain in relative production due to the decrease in horse and mule numbers will not be greatly increased. According to the Agricultural Outlook for 1934-35, it is probable that the decline

in the number of horses and mules on farms will be halted between 1936 and 1938.^{5/} Colt production increased in both 1933 and 1934 and horse and mule prices have trended upward since 1932. But even if numbers are stabilized in 1936 to 1938, the decrease from the average level of 1931-1933 is expected to amount to about 1.6 million head so that an additional crop acreage of 5 million acres will be released to commercial production. The city and industrial market for horses and mules has almost disappeared. And the agricultural demand for workstock after 1936-1938 will depend upon the crops grown, the prices obtained, and the extent to which mechanical power is substituted.

It is probable that yields of the principal crops, with the exception of cotton, will be maintained through the next decade at about the average level for the period 1923 to 1932. The yield of cotton can apparently be maintained at the average for 1930 to 1934.

The average yields of corn, oats, wheat, cotton, and tame hay are given in Table 3 for the period from 1919 through 1933, with the exception of corn which is given for the period from 1904 through 1933. For any given year, of course, the yields of the several crops are seriously affected by the weather. As given, however, the yields are expressed as 3-year moving averages centered on the second year so that a considerable portion of the fluctuation due to weather has been removed.

The average yield of corn per harvested acre apparently declined or trended downward from 1919-1921 to 1932-1934. This apparent trend, however, is almost altogether a function of the period selected since the exceptionally high yields of 1920, 1921, and 1923 are included in the averages at the start and the exceptionally low yields of 1930, 1933, and 1934 are included in the averages at the end of the period. Almost exactly the same type of trend is

^{5/} The Agricultural Outlook for 1934-35, U.S. Department of Agriculture, Released for publication November 5, 1934.

indicated by the data for 1906 to 1919 as for 1920 to 1933, and for exactly the same reason. It would seem to be a reasonable assumption that the average yield of corn for the period from 1923 to 1932, which was not affected by the high yields of 1920 and 1921 or the severe drought of 1934, will be maintained. The yields of tame hay, oats, and wheat have, if the effect of severe drought in 1934 is discounted, been about stable since 1920 and it is reasonable to expect that the 1923-32 average will be maintained.

Table 3.- Yields Per Acre Harvested of Corn, 1906-1933, and of Tame Hay, Oats, Wheat, and Cotton, 1920-1933.

Year	: Corn	:	Year	3-Year Moving Average Yield Per Acre of:				
				: Corn	: Tame Hay	: Oats	: Wheat	: Cotton
	: Yield	:						
	: <u>bu.</u>	:		: <u>bu.</u>	: <u>tons</u>	: <u>bu.</u>	: <u>bu.</u>	: <u>pounds</u>
1906	: 30.3	:	1920	: 27.2	: 1.32	: 28.2	: 13.0	: 161.7
1907	: 29.9	:	1921	: 28.7	: 1.28	: 28.4	: 13.3	: 156.0
1908	: 28.6	:	1922	: 28.6	: 1.30	: 27.3	: 13.3	: 139.2
1909	: 26.7	:	1923	: 27.9	: 1.34	: 31.0	: 14.4	: 150.1
1910	: 27.0	:	1924	: 26.1	: 1.29	: 32.1	: 14.0	: 158.3
1911	: 26.1	:	1925	: 26.5	: 1.27	: 30.8	: 14.5	: 177.1
1912	: 27.1	:	1926	: 25.7	: 1.31	: 28.5	: 14.1	: 176.0
1913	: 25.4	:	1927	: 27.0	: 1.35	: 28.9	: 14.9	: 172.6
1914	: 25.9	:	1928	: 26.7	: 1.40	: 29.8	: 14.4	: 163.0
1915	: 25.5	:	1929	: 26.7	: 1.32	: 31.5	: 14.2	: 161.5
1916	: 26.0	:	1930	: 24.5	: 1.27	: 29.9	: 14.5	: 177.5
1917	: 26.1	:	1931	: 23.6	: 1.25	: 30.1	: 14.5	: 180.6
1918	: 24.7	:	1932	: 23.9	: 1.25	: 26.0	: 13.5	: 197.8
1919	: 25.8	:	1933	: 24.7	: 1.18	: 22.1	: 11.8	: 181.5
:	:	:	:	:	:	:	:	:

Since 1921-1923, the trend in the average yield of cotton has been upward. The general spread of the boll weevil caused the average yield of cotton to drop from 200 pounds per acre harvested in 1910-1914 to 154 pounds in 1920-1924. As the boll weevil was brought under partial control, the average yield was increased to approximately 180 pounds per acre harvested in 1930-1934 and it is believed that this increased yield can be maintained.

The acreage of the crops which have been considered usually accounts for at least 80 per cent of the total acreage of harvested crop land. Of the crops which account for the other 20 per cent, the average yield of barley per acre should be maintained at about the 1923-1932 level, the average yield of grain sorghums has shown about the same downward trend as corn since 1919-1921 and for about the same reason, the average yield of wild hay is closely related to the average yield of tame hay, and the average yields of the several

Table 4.- Grain Available for Livestock Feed and Required at Average^{1/}
Rations for Livestock Production, 1910-1912 to 1931-1933.

Year	Tons of feed Available	Livestock Numbers or Production					Feed Required	
		Horses and Mules	Pork Produced	Milk Produced	Beef Produced	Number Chickens	Percent of Available	Total Tons
	Millions	Million head	or billion pounds produced				Percent	Millions
1910-12	86.5	27.7	12.3	72.5	12.4	338	99.0	85.6
1913-15	87.5	28.3	13.1	74.0	10.9	350	100.3	87.8
1916-18	94.9	28.1	13.9	76.0	12.4	361	95.7	90.8
1919-21	95.1	27.6	14.6	81.0	12.3	365	97.4	92.6
1922-24	96.3	25.5	16.5	88.8	12.4	421	101.3	97.6
1925-27	91.7	23.0	14.9	95.6	12.7	431	100.8	92.4
1928-30	93.7	20.2	16.2	101.3	11.5	461	99.5	93.2
1931-33	93.2	18.2	16.3	104.9	11.7	458	98.4	91.7

^{1/} Corn, oats, barley, grain sorghums, rye, and wheat corrected for exports, changes in stock, seed, and industrial utilization. Estimated numbers and production of livestock. Horses and mules in cities and milk production in cities and villages included. Grain required based on an allowance of 2,250 pounds per horse or mule and 60 pounds per hen on January 1, of 460 pounds for hogs and 100 pounds for beef cattle per live hundredweight slaughtered, and of 27 pounds of grain or silage as grain equivalent per hundredweight of milk produced. Subject to revision.

special crops are so dependent upon the care given them that it is almost certain their yields can be maintained.

The probable yield or contribution of pasture land must also be considered. Such data as are available suggest that there has been a steady downward trend in the yield or condition of pasture land since 1919. For example, the average condition of dairy pastures as currently reported by

the Department for the April to October season declined from 84 per cent of normal in 1919-1923 to 80 per cent of normal in 1924-1928, to 70 per cent of normal in 1929-1933. In addition, the decrease of 7.4 million head in the number of horses and mules on farms from 1920-1922 to 1931-1933 released a large acreage of pasture land so that the acreage of pasture per animal unit should have been increased and over-grazing decreased. Although the yield of pasture has apparently decreased, it should be remembered that a large part of the apparent decrease is certainly due to the unusual combination of a drought in 1930, in 1933, and again in 1934, and that pasture has apparently been substituted for hay to a considerable extent since 1930-31.

It is probable that the efficiency of livestock production per unit of feed fed will be about maintained or only slightly increased from the level of 1919-1933. As indicated in the seventh column of Table 4, where the grain required at average rations for livestock production from 1910 to 1933 is compared with the grain available for livestock, it is doubtful if there has been any marked increase in the direct efficiency of feeding livestock between 1910-1912, when the required grain is estimated at 99 per cent of the available grain, and 1931-1933, when the required grain was 98.4 per cent of the available grain. The grain required was computed by applying the same average rations to the number of livestock on hand or to production in each period. The increase in the average value of the net production relative to the quantity of grain fed was due to the decreased consumption of grain by horses and mules and the consequent increase in the production of milk, eggs and poultry, and pork rather than to an increase in the direct efficiency of grain feeding as such.

Such data as are available, however, suggest that the efficiency of production with respect to the quantity of hay fed has increased and that the efficiency of production with respect to the quantity of grain fed might be improved if grain prices were maintained at a sufficiently high level. A shortage of 5 to 10 per cent is indicated in the quantity of hay required at average rations relative to the quantity available in 1931-1933 as compared with 1920-1922. It is probable, however, that the decrease in the quantity of hay fed has been associated with the acreage of pasture released by the decrease in the number of workstock and with the drought situation since 1930 rather than with an actual increase in the efficiency of production. The quantity of grain fed is usually 5 to 10 per cent short of the quantity required at average rations when the grain supply is short and prices are high, and usually 5 to 10 per cent over the quantity required when the supply and price situation is reversed. If the supply of grain could be conserved and wasteful feeding prevented when the yields and production of feed grains are above average requirements, as in 1932-33, some increase in the direct efficiency of livestock production might be obtained.

It is probable that the increase in the efficiency of agricultural production due to the shift to the crops and classes of livestock which return the most value per acre of land, or per animal, and to the specialization or concentration of production will continue to cause a gradual increase in the efficiency of agricultural production.

Every farmer, of course, is interested in so adjusting his output as to obtain an increased income, and it is reasonable to suppose that the actual degree of adjustment achieved will continue to increase as the general economic situation is stabilized and as cooperative action is made possible through

such agencies as the Agricultural Adjustment Administration. It is difficult, however, to obtain a measure of the increased efficiency of production due to the adjustment factor. The use of the index of net agricultural production in this discussion, for example, has been based on the assumption that the annual changes in the volume of the net agricultural production from 1919 to the present could be exactly determined on the basis of the average price structure for the period 1919 to 1927. Such a fixed weight method must result in some distortion of the index for the individual years within the base period and may result in a very considerable distortion when applied to so different a period as 1929-1933. A diversion of feed to such classes of livestock as can convert it into a maximum amount of food or a concentration of the production of such crops as corn, cotton, and wheat in the areas where the highest yields of the several crops are obtained is of course equivalent to an increase in the efficiency of physical production. Such shifts, however, must be considered from the economic as well as from the physical viewpoint.

So far, it has been assumed that cropping systems will not be changed and that farm population will tend to either remain stable or to move back toward the pre-depression level. Should crop rotations be improved, better seed used, or more fertilizer applied, an increased efficiency of production relative to crop land would result. Or, should the depression continue and force a substantial increase in farm population, the efficiency of production relative to farm population might well be decreased.